

# **Quantitative indicators and life history implications of environmental stress on sturgeon**

**Dietmar Kueltz**

# Final Selection Panel Review

## Proposal Title

#0085: Quantitative indicators and life history implications of environmental stress on sturgeon

## Funding:

Fund with future funds

Amount: \$999,481

The only public comments received were from the applicant's PI clarifying two points made in the Selection Panel (Discussion) Review; 1) exceeding the page number, and 2) whether CALFED can fund major equipment. These points were discussed by the Selection Panel and should not change the Technical Panel's previous rating.

The misunderstanding on page limitation was due to confusion on what constitutes a collaborative proposal. Proposals are collaborative only if they involve applicants from different institutions. Different departments within an institution do not qualify a proposal as collaborative.

On the second point the Selection Panel did not consider the funding of the mass spectrometer to be an adequate match since UCD was including a manufacturer's discount as part of their funding. Also, State contracting limitations would make it problematic to purchase equipment beyond the 3 year study period.

Most reviewers agreed that sturgeon were not necessarily the best choice for the proposal because they could accumulate MeHg and SeMeg outside the Bay-Delta region (either upstream or from other river systems).

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## Final Selection Panel Review

The final Selection Panel agreed with its original recommendation on the merits of this proposal. Due to the recent reduction in funds available for the Science Program's 2004 PSP, the Selection Panel has been forced to place this proposal in the Fund with Future Funds category. This decision was based solely on the current programmatic priorities of CALFED and the current level of available funds for purposes of supporting research efforts of this nature. This decision was not a reflection of the technical merit of this proposal.

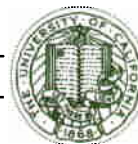
## **Public Comments**

The following public comments were received for this proposal.

#83

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5/24/05

## **RE: CALFED SCIENCE PSP Proposal # 0085: Quantitative indicators and life history implications of environmental stress on sturgeon**

As the PI of proposal # 0085 I would like to comment on behalf of all Co-PIs of this project on the scientific and technical reviews our proposal received:

1. We are extremely gratified that our efforts in developing a strong collaborative proposal were recognized as such by all three reviewers and by the review panel sessions and that the proposal received excellent scores and was recommended for full funding.
2. The first reviewer noted that the page limitations were apparently exceeded but this must be a misunderstanding because we have verified by calling CALFED staff prior to writing the final version of this proposal that collaborative proposals are allowed 5 additional pages "on top of the 20 page limit" per additional collaborator. This was also explicitly stated in the instructions for preparing proposals for the Science Program PSP. Since our proposal represents a collaboration of 5 research groups the number of pages (25 less figures) is by far less than the number of pages allowed ( $20 + 5 \times 5 = 45$ ). Thus, we do not understand the basis for this criticism.
3. We contacted CALFED officials via phone and email prior to developing this proposal to ask whether major equipment could be requested if necessary for the project. The answer was yes. Because of this possibility we mounted a major effort to develop this proposal because we would like to introduce cutting-edge proteomics into ecologically relevant biological research on non-model organisms. We have conveyed in the proposal that it depends on a mass spectrometer that is capable of N- and C-terminal sequencing of unknown proteins. Such instrument is not available on the UC Davis campus. Available instruments in the Medical School, etc. are for use with model organisms (with fully sequenced genomes) that are of no interest to CALFED. We would not have proposed this project if we had been advised that CALFED does not fund major equipment and we could not carry out this project without a designated mass spectrometer that meets our objectives. We have secured matching funds to minimize the cost for CALFED as we have tried to streamline and be very modest with the budget in general (which was recognized and acknowledged by the reviewers).

Yours truly,

A handwritten signature in blue ink, appearing to read 'Dietmar Kueltz'.

Dietmar Kueltz  
Associate Professor of Physiological Genomics  
Department of Animal Science  
UC Davis

# Initial Selection Panel Review

## Proposal Title

#0085: Quantitative indicators and life history implications of environmental stress on sturgeon

## Funding:

Fund

Amount: \$999,481

## Initial Selection Panel (Primary) Review

### Topic Areas

- Life Cycle Models And Population Biology Of Key Species
- Environmental Influences On Key Species And Ecosystems
- Relative Stresses On Key Fish Species
- Implications Of Future Change On Regional Hydrology, Water Operations, And Environmental Processes
- Assessment And Monitoring

Please describe the relevance and strategic importance of this proposal in the context of this PSP. How does the proposal address the topic areas identified above? What are the broader CALFED Goals this proposal may meet that are not accounted for in these specific topic areas?

This proposal will analyze the effects of bioaccumulation of Selenium(SeMet) and Mercury(MeHg) in green and white sturgeon grown at UCD. Green sturgeon are a CALFED at-risk species and have recently been proposed for ESA listing as threatened by NMFS. The study is designed to look at multiple responses to different combinations of pollutant stresses and environmental factors such as temperature and salinity. The study would be useful in determining the relative importance of such impacts compared to other more obvious impacts such as increased export pumping rates. Data obtained could be used to guide management decisions on amounts of selenium that can be

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## Initial Selection Panel Review

disposed of without harm to at-risk fish populations in the Delta. Information on temperature stress has practical implications for water management operations, such as the timing of cold-water releases from reservoirs during periods of early development. A major problem associated with wetland restoration projects and floodplain inundation is the risk to humans and fish of increasing Mercury contamination. This study will provide the tools for assessing the impacts of these stressors on sturgeon life history. The research supports the long-term CALFED goal of developing quantitative models to assess population changes in response to multiple environmental stressors. The proposal is consistent with the CALFED Mercury Strategy Paper developed by an independent team of mercury experts (Mercury Strategy for the Bay-Delta Eco-systems: A Unifying Framework for Science, Adaptive Management, and Ecological Restoration, 2003). The novel approach used for sturgeon in this project can easily be adapted in the future to other at-risk species such as; Chinook salmon, steelhead, splittail and Delta smelt.

The budgets of proposals submitted in response to this PSP are larger, on average, than those submitted to CALFED in previous years. The Science Program is committed to getting as much science per dollar as is reasonably possible. With this commitment in mind, can the proposed budget be streamlined? If so, please recommend and clearly justify a new budget total in the space provided.

UCD should cover the cost of a new T3 mass spectrometer (\$299,989), thereby reducing the proposal to \$699,492. The University will end up with sole ownership of this expensive equipment after the study is completed. Although the proposal states it will be available to other researchers that propose to use it in the future. Several additional pages were added to this proposal to justify the expense of this new equipment that is deemed essential for the core component of the proposal (i.e., identifying environmental stress-specific proteins). The justification makes a case for continued use of this equipment (and therefore continued funding) by CALFED for future projects so that results can be obtained for other at-risk fish species (e.g. Chinook salmon, Delta smelt, etc), however, this would definitely give UCD a significant advantage in future proposals of this type. If there is a

## Initial Selection Panel Review

CALFED policy on the purchase of major equipment as part of proposals it needs to be reviewed for this could set a precedent for other studies.

### Evaluation Summary And Rating.

Provide a brief explanation of your summary rating and any additional comments you feel are pertinent.

I strongly recommend that this proposal be funded based on the value of information obtained and the multiple CALFED PSP objectives that are met. The proposal is well written and the approach will generate a wealth of knowledge on effects of contaminants in concert with environmental stresses. It is more likely that a combination of stressors (e.g., pesticide cocktails) are resulting in significant biological responses in Delta fish species, rather than a single contaminant. This proposal integrates the resources of five experts in their fields at UCD to provide quantifiable data. It was rated superior by the Technical Panel and reviewers agreed that integrated, multiple scale approach was exciting and promising. The only weaknesses were relating biological responses to population level response and the relevancy to global climate changes (e.g., sea rise due to melting polar ice caps), which are always difficult. Also, if this proposal were to be revised I would include a comparison of contaminant concentration levels found in the environment (e.g., white sturgeon, striped bass, largemouth bass, Chinook salmon) to study fish and include what the EPA standards are for human health risks. There did not appear to be an evaluation of effects related to threshold concentrations associated with impaired reproduction or spawning success that would be essential for an assessment of the population-level effects.

### Selection Panel (Discussion) Review

fund this amount: \$999,481

note:

fund

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### Initial Selection Panel Review

The panel agreed that this is potentially a good tool to develop to look at pollutant stresses in fish resulting from mercury and selenium bioaccumulation, and one that is consistent with the 2003 CALFED Mercury Strategy & Framework. The panel also agreed that the technical aspects of the proposal were strong. This may be an approach that would be applicable on a broader, national scale.

The comparison between green and white sturgeon could be beneficial because of the differences in life history - this tool could be expanded into other species. However, they expressed reservations about the choice of sturgeon as a model organism. Sturgeon are longer-lived, and may accumulate contaminants during their migrations from outside the Bay-Delta, so may not be representative of other fishes of concern in the Bay-Delta. In addition, there are physiological reasons that sturgeon are not comparable to other fish.

Another reservation was a major aspect of the budget - the purchase of a mass spectrometer. Although UCD would pay for ~1/3 of the machine, state contracting limitations make it potentially problematic to purchase major equipment with a lifespan beyond the end of the work funded by this grant. Could this equipment be leased, or could funding be made contingent on finding matching funding from another source for the mass spec purchase? Could collaboration be found with another collaborator such as Medical Research bodies, who already had the necessary infrastructure for the analytical work?

**Panel Ranking: Fund with reservations**

# Technical Synthesis Panel Review

## Proposal Title

#0085: Quantitative indicators and life history implications of environmental stress on sturgeon

Final Panel Rating
superior

## Technical Synthesis Panel (Primary) Review

### TSP Primary Reviewer's Evaluation Summary And Rating:

An impressive team of UC Davis scientists spanning expertise from molecular to whole organism biologists proposes to look at multiple scales of response to relevant environmental stresses imposed on differing life stages of California white and green sturgeons. Stresses include the single or interactive effects of SeMet (agriculture), MeHg (historical pollution), and rapid increases in temperature and salinity. Organism responses include, survival, growth, development, swimming performance, and respiration; cellular and subcellular responses include histopathology, specific protein stress responses (i.e., HSP), and innovative proteomic and tissue microassays (TMAs). The study depends heavily on a large and complex rearing study where fish are dosed with contaminated food, and distribution of experimental fish across several laboratories and related measurement end-points. Research is relevant to watershed and sturgeon management issues in the Sacramento San Joaquin system due to high SeMet contamination in sturgeon, its likely mechanism of uptake (foraging on benthos), and probable more subtle effects (cellular-organismal) than obvious population level impacts (death, growth, fecundity).

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## Additional Comments:

The assembled team is uniquely qualified to undertake the ambitious set of experiments and coordinate sharing of experimental fish and tissues. Investigating effects of contaminants in concert with environmental stresses is a particularly attractive feature of the experiment, as it is likely the cumulative effect of stressors that result in significant biological response. The project will make sturgeons a model species for development of field tool kit (tissue micro-array system), which will permit any field biologist to preserve tissue for later screening of biomarkers relevant to physiological stress. A potential problem in the experimental design was continued handling and dispersals of experimental fish, which could confound some end points (i.e., growth and survival). Budget is brought up to 1 million in large part due to an equipment request for a Ultraflex T3 sequencing mass spectrometer. The PI s argue that this is an essential piece of equipment to undertake analyses in support of rapid screening of multi-protein stress responses. The proposal was substantially over the page limit - 31 pages, which may have given this proposal an unfair advantage. There was sufficient redundancy to have reduced the length of the proposal, but extra length did permit increased understanding of justification and background. The proposal struggled to link organismal and other biological responses to population level responses, but this remains a challenge for all in ecotoxicology field. Figure 2, Conceptual Model, is a bit naïve and untenable at higher biological levels. I found idea that responses would be relevant to global climate change a bit overdone (also sea level rise in moderate term will rise due to temperature's effect on water expansion and continued glacial rebound, not melting polar caps). Still, responses will be relevant to watershed management regimes that can cause large changes in temperature and salinity. Reviewers agreed that the integrated nature of the proposal and its use of multiple stressors in concert with multiple scale biotic responses was very exciting and promising. Despite large innovation, reviewers viewed the proteome and tissue microarray approaches as feasible. The track record of the PI s was complimented and their prospect for producing innovative

## Technical Synthesis Panel Review

and useful research products highlighted. One reviewer would have rated proposal excellent were it not over the prescribed length.

An impressive team of UC Davis scientists spanning expertise from molecular to whole organism biologists proposes to look at multiple scales of response to relevant environmental stresses imposed on differing life stages of California white and green sturgeons. Stresses include the single or interactive effects of SeMet (agriculture), MeHg (historical pollution), and rapid increases in temperature and salinity. Organism responses include, survival, growth, development, swimming performance, and respiration; cellular and subcellular responses include histopathology, specific protein stress responses (i.e., HSP), and innovative proteomic and tissue microassays (TMAs). The study depends heavily on a large and complex rearing study where fish are dosed with contaminated food, and distribution of experimental fish across several laboratories and related measurement end-points. Research is relevant to watershed and sturgeon management issues in the Sacramento San Joaquin system due to high SeMet contamination in sturgeon, its likely mechanism of uptake (foraging on benthos), and probable more subtle effects (cellular-organismal) than obvious population level impacts (death, growth, fecundity).

## Technical Synthesis Panel (Discussion) Review

### TSP Observations, Findings And Recommendations:

Quantitative indicators and life history implications of environmental stress on sturgeon

This proposal is very innovative and unique. Investigating the effects of contaminants in concert with environmental stresses is a particularly attractive feature of the experiment, as it is likely that the cumulative effect of stressors will result in a significant biological response. Further, the diverse set of PIs will investigate ecotoxicological effects of multiple biological levels. The proposal pulls together the

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### Technical Synthesis Panel Review

developmental and experimental aspects very well. The level of coordination is high. The panel expressed concern regarding the absence of a research link to population level responses. The panel noted that the investigator group is strong in ecophysiology, but does not possess ecological levels expertise. SeMet is only considered as an additive effect to Mercury and antagonistic effects were not discussed. It is important to relate tissue concentrations with what is found in environment.

Final Ranking: Superior

# Technical Review #1

proposal title: Quantitative indicators and life history implications of environmental stress on sturgeon

## Review Form

### Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

<b>Comments</b>	Yes, this is a very well written proposal. The research is indeed timely, very important, well conceived, and well proposed
<b>Rating</b>	excellent

### Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full-scale implementation project justified?

<b>Comments</b>	Yes, the PIs are very knowledgeable in this field. The proposal states clearly the underlying basis for this work and the group that has been assembled is very appropriate.
<b>Rating</b>	excellent

### Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

<b>Comments</b>	
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#0085: Quantitative indicators and life history implications of environmental...

## Technical Review #1

	This approaches outlined are cutting edge and very appropriate. The group certainly has the expertise to complete this work. The data gathered will be a model for future work on the effects of environmental contaminants on fish species, including those that are endangered.
Rating	excellent

## Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?  
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	The PIs have the background and expertise to make this very extensive study feasible. The scale is appropriate for this group.
Rating	excellent

## Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	The proper controls are outlined in the proposal.
Rating	excellent

## Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	The product of this research will be the technologies and approaches that the group will develop.
Rating	excellent

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## Technical Review #1

### Additional Comments

Comments	This is an excellent proposal, using multiple, cutting-edge approaches to address a very important, and general, environmental problem.
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### Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	This is an excellent, distinguished team of investigators with a proven track record.
Rating	excellent

### Budget

Is the budget reasonable and adequate for the work proposed?

Comments	The budget is reasonable, despite the high cost of Mass Spec., especially with the cost sharing from UC Davis.
Rating	excellent

### Overall

Provide a brief explanation of your summary rating.

Comments	Great proposal from an excellent group. It is well written and important.
Rating	excellent



# Technical Review #2

proposal title: Quantitative indicators and life history implications of environmental stress on sturgeon

## Review Form

### Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	The purpose of this project is to analyze the effects of selenomethionine on sturgeon in the presence of secondary stressors such as methyl mercury, heat, and/or a change in salinity. These goals are consistent throughout the project and this area of research is timely and important. The research performing proteomic and tissue microarrays is a new and encouraging area of research that may provide significant incite into the mechanisms of toxicants and the effects of multiple stressors. Combined with physiological measurements this research is important and correlative.
Rating	excellent

### Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full-scale implementation project justified?

Comments	The study is well justified and a conceptual model is clearly stated. The justification is well written and fully if not copiously describes the need for this project, each of its tasks and the outcomes.
Rating	

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## Technical Review #2

	excellent
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### Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	<p>The approach is well designed and appropriate for meeting the objectives of the project. The results will add to our knowledge base and provide information that will be useful to scientists and environmental managers in the future. Furthermore, the novel proteomic and tissue microarray methods combined with physiology data will generate novel information that will be immediately useful to decision makers and for scientists performing site monitoring.</p> <p>Task 5 incorporates heat shock proteins as biomarkers of stress, which is not novel. However, determining whether early developmental stages are sensitive to heat shock stress because of a lack of heat shock protein is novel (Objective 1a) as is correlating HSP content to abnormalities (objective b).</p> <p>In constrast, task 5, objective 2a "in stages that induce HSPs, the threshold temperature for SP induction depndes on the baseline growth temperature"-the reviewer does not see how this point is being addressed and a well designed approach is not found within objective 2a.</p> <p>Task 6 in combination with tasks 1-4 provide novel information lacking in this field and</p>
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## Technical Review #2

	has the potential to correlate pathology, physiology and molecular data. Fantastic!
Rating	excellent

## Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?  
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	The approach, the methods and the experimental design are well documented, technically feasible and appear destined for success based on the expertise of the authors and the detailed methodology provided.
Rating	excellent

## Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	Data provided within this proposal should be of use to environmental managers monitoring sites of concern.
Rating	not applicable

## Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	This product will likely produce considerable products of value, including increased knowledge of the mechanisms of single stressors and those in combination. It will provide information on potential effects of combinations of events. Furthermore, it will provide novel, mechanistically based
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## Technical Review #2

	<p>biomarkers of Se, HcMg, heat stress, salinity, and Se in combination with these other stressors. Both protein and tissue biomarkers will be produced that can be important monitoring tools for environmental managers and decision makers that are testing sites periodically. The products produced should have immediately effects.</p> <p>Furthermore, the authors maintain a large database that can be accessed by managers who may want to collaborate and determine some of the best and easiest to use biomarkers for multiple stressors at sites of concern.</p>
Rating	excellent

## Additional Comments

Comments	<p>The overall description and figures that demonstrate how the different tasks and different labs will work together provide a model for how a collaborative proposal should be written.</p>
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## Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	<p>The track record of each of the authors is superb. The authors have published in some of the best peer-reviewed journals in their respective fields. They obviously have the intellectual capital necessary to perform the project. Furthermore, they have the available infrastructure and administrative support to accomplish the project. They believe they lack one piece of equipment necessary to perform the project and ask for it as part of the</p>
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## Technical Review #2

	project.
Rating	excellent

### Budget

Is the budget reasonable and adequate for the work proposed?

Comments	The budget is reasonable and adequate for the work proposed. I am not sure that I would consider a discount on an MS a budget match; however, the budget is very reasonable and this philosophical difference is unimportant in the overall explanation of the budget.
Rating	excellent

### Overall

Provide a brief explanation of your summary rating.

Comments	<p>The proposal body is 31 pages long, which is certainly longer than the 20 page limit. The reviewer recognizes that there are 11 figures that should not be counted within the 20 pages. At a little more than a half-page per figure the proposal is dropped to 25 pages, which is still greater than the 20 page limit expressed above. The proposal is a fantastic proposal; however, the extra pages and greater explanation that this affords, provides a selective advantage to the authors that is not fair. If this was a NIH or NSF proposal it would be thrown out for not following format.</p> <p>How this should be considered in the overall rating by CAL-FED administrators is unknown to the reviewer. However, this reviewer is going to reduce the rating of the proposal based on this faux pas. I suggest if this faux pas is not important to the CAL-FED administrators than please raise the rating to excellent. However, be aware that you may be setting a</p>
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Technical Review #2

	<p>bad precedent for future proposals unless you begin to set strict formatting rules.</p> <p>Besides that, I consider this proposal excellent, as it is well written, well thought out, and will be performed by experts in the field.</p>
Rating	very good

# Technical Review #3

proposal title: Quantitative indicators and life history implications of environmental stress on sturgeon

## Review Form

### Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	The overall theme of this study is the impact of anthropogenic disturbance on native fishes in the Bay/Delta water system. One class of perturbation is toxic materials (selenium and mercury) and the other encompasses effects of global climate change on the system. Specifically, the study focuses on the impacts and stress responses of two pollutants (selenomethionine and methyl mercury) and impacts of temperature and salinity perturbations on Green and White Sturgeon. The objectives and hypotheses are clearly stated as are the tasks of the individual investigators.
Rating	excellent

### Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full-scale implementation project justified?

Comments	The strength of this proposal lies in the way the stress responses to anthropogenic materials will be studied. In addition to testing for whole organism responses at various developmental stages, the proposal also includes elucidation of actual mechanistic responses at the cellular and molecular
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### Technical Review #3

	levels. This approach requires a collaborative effort and this proposal is an excellent example of the integration of skills of different collaborators. I found the conceptual model to be very useful in understanding the organization of this complex project. The authors have done a commendable job in relating the proposal to the existing literature and in organizing the study.
Rating	excellent

## Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	I found the Approach and Methods section to be clearly written and fully appropriate for achievement of the project goals and objectives. Because of the complexity of the study and the involvement of five different research groups, I was pleased to see in Task 1 that quarterly meetings are planned to maintain communication and coordinate work efforts. The overall success of the entire project hinges on Task 2 being able to provide sturgeon embryos and larvae for use in other tasks. Considering the experience of Doroshov and other collaborators, the odds of success of this task are excellent. Objective (b) of Task 2 involves examination of temperature effects on larval development and also provides larvae for examination of temperature induction of proteins in Tasks 5 & 6. In the experimental design of this section, I am not sure if aliquots of control fish will be preserved at 6, 24 and 72 h in parallel with the experimental groups. This would seem to be desirable for testing the hypothesis of heat induced proteins. Sample size and replication seem appropriate for all of the tasks involving experiments. The use of hatchery produced larvae in Task 2 allows for generally high numbers of
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### Technical Review #3

	replicates and thus the potential for good statistical power. The study will clearly provide new information on impacts of anthropogenic perturbations on the Bay/Delta system. The most unique aspect of the study is the integration of various levels of organization (whole organism, cellular, molecular). Assuming the project is funded, I hope that when results are published that this integrated approach is not lost. Even though papers specific to each level of organization will be published, there should also be overview papers that capture the entire project.
<b>Rating</b>	excellent

### Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?  
Is the scale of the project consistent with the objectives and within the grasp of authors?

<b>Comments</b>	Even though the study uses cutting-edge approaches in some sections, all approaches have been documented in the literature. The collective expertise of the investigators gives one great confidence in the likelihood of success. The research team is very nicely matched with the project objectives.
<b>Rating</b>	excellent

### Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

<b>Comments</b>	This is not a monitoring proposal
<b>Rating</b>	not applicable

### Technical Review #3

## Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	As mentioned above, this project has the potential to result in important publications and to very useful knowledge (e.g., induction of stress proteins) that would be important in monitoring the environmental health of the Bay/Delta system.
Rating	excellent

## Additional Comments

Comments	I am impressed by the level of integration shown in this proposal and by the very strong research team that has been assembled. If the collaboration/integration continues throughout the entire process (if funded), this will be a very powerful study.
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## Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	The research team assembled for this project is impressive and beautifully matched to the stated objectives. The appropriate infrastructure is available, with the exception of a major piece of equipment (Ultraflex T3 sequencing mass spectrometer). Partial funding for this instrument is requested in the proposal. The proposal also includes documentation of matching funds from the University of California at Davis and a substantial price discount from the manufacturer.
Rating	

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### Technical Review #3

	<b>excellent</b>
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## Budget

Is the budget reasonable and adequate for the work proposed?

<b>Comments</b>	The budget is surprisingly low for a project of this magnitude. This is primarily because the salary for four of the five principal investigators (along with fringe benefits) is being covered by UC Davis.
<b>Rating</b>	<b>excellent</b>

## Overall

Provide a brief explanation of your summary rating.

<b>Comments</b>	In reading this proposal I was immediately impressed by the clear conceptual design, the multiple scales of the investigation, the high level of integration of the tasks, and the stellar quality of the principal investigators. The overall research question is timely and very appropriate for the Bay/Delta system.
<b>Rating</b>	<b>excellent</b>

